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(54) FILTER ASSEMBLIES AND CARTRIDGES THEREFOR

(71) We, TECAFILTRES, a French Corporate Body, of Ancienne Route de Fontainebleau, 91550 Paray-Vieille-Poste, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to filter assemblies, and to filter cartridges therefor, for filtering fluids. It is applicable to many types of filters, for air, oil, water etc., but is particularly intended for air filters for internal combustion engines, especially the engines of motor cars or similar vehicles.

As will appear from the following description, the invention provides filter (or filtering) cartridges including a filter (or filtering) element such as, for example, one made of folded porous paper, parts of which are embedded directly in end caps made of a thermoplastic material such as polypropylene. The embedding is done only by heating without use of a binder.

Filtering cartridges have been known hitherto which have been constituted by a filtering element proper of a cylindrical general shape, on the two end faces of which there are attached by moulding two end caps made of thermoplastic material to a predetermined shape with deformed portions for use as sealing elements.

These end caps are sometimes of a composite nature comprising, for example, a material for securing the filtering element, a rigid material and a material which swells during the moulding operation to provide sealing-tightness. Filter cartridges are also known wherein the end caps are made of a cellular product secured by an adhesive to the filtering element.

Some of these constructions require complicated and cumbersome moulding apparatus. The moulding operation is delicate because of the fragile nature of the filtering element, which will not stand up to heavy axial load, and the usually pasty state of the material which is to constitute the end caps.

Furthermore, these methods often require the successive manipulation of several products, a substance constituting the filtering element, a substance constituting the end caps and a glue or adhesive.

An object of the present invention is to provide an improved filter cartridge which obviates these disadvantages.

According to one aspect of the present invention there is provided a filter assembly comprising a filter cartridge including a filter element for filtering a fluid, opposite ends of the filter element being embedded directly in end caps of thermoplastic material, said filter cartridge being housed in a casing with a cover, one of the end caps comprising the cover for the casing. The invention also resides in such a filter cartridge *per se*.

The filter element will usually be made of folded porous paper and the end caps are preferably made of polypropylene, this being a product which can be cut and moulded and is easy to manipulate, is very stable under thermal or chemical attack and of a low cost price.

According to another aspect of the invention there is provided a method of assembling a filter cartridge comprising introducing an uncapped end of a filter element into a cover for a casing for the cartridge, the cover being of thermoplastic material, and applying heat to embed and sealingly bond the end of the filter element directly to said cover which then constitutes an end cap for that end of the filter element, and similarly embedding and bonding the opposite end of the filter element to another end cap of thermoplastic material.

No assembly mould is required, though a jig may be used in a manner described hereinafter. No fixing or glueing substance is used. The method requires no force capable of damaging the filtering element, and it can be carried out very rapidly.

It permits the production of seals without adding any additional parts. It also allows the cover and casing of the filter housing to be used directly for constituting the end caps of the filter element, allowing the provision of filter assemblies which cannot be disassembled, are very cheap, and can be thrown away after they become clogged.

The invention will now be described, by way of example, with reference to the accompanying drawings which show seven constructional forms of filter cartridge, with three different ways of obtaining the necessary heating effect for assembling the parts. In the drawings:

Fig. 1 shows in perspective a first form of filtering cartridge to illustrate some of the constructional features of the cartridges of Figs. 7 and 8 which embody the invention;

Fig. 2 shows a view in diametral section of this cartridge with heating units which may be used for assembling the parts, which units may be employed in the method of the invention;

Fig. 3 shows a view in diametral half-section of a second form of cartridge and a second method of heating for assembly purposes;

Fig. 4 shows a view in diametral half-section of a third form of cartridge and also a third method of heating for assembly purposes;

Fig. 5 shows a view in diametral half-section of a filter assembly comprising a fourth form of cartridge mounted in a filter housing, the said cartridge having sealing means which may be provided with cartridges embodying the invention;

Fig. 6 shows a view in diametral half-section of a filter assembly comprising a fifth form of cartridge mounted in a filter housing, the said cartridge having other sealing means which may be provided with cartridges embodying the invention;

Fig. 7 shows a view in diametral section of a filter assembly comprising a cartridge embodying the invention, which uses directly as the upper end cap the cover of the filter housing in which it is mounted;

Fig. 8 shows a view in diametral section of another filter assembly comprising a cartridge embodying the invention, which uses directly as the end caps on the one hand the cover and on the other hand the casing of the filter housing.

Referring to the drawings, a method of forming the filtering cartridge of Fig. 1 will first be described with reference to Figs. 1 and 2. To construct a cartridge of this kind, two end caps 1 and 2 are cut from a sheet of polypropylene of slight thickness, for example two millimetres. These caps, as illustrated, are in the form of annular discs the radial width 3 of which is uniform, slightly greater than the width 4 of the filtering element 5 which they will receive.

The end caps 1 and 2 may however be given any desired shape adapted to the shape of the filter housing which will contain the cartridge. For example they may be in the form of a circular ring, or a regular or other oval shape, or in the shape of a straight-sided figure which may or may not be of rectangular or other regular configuration, or any other convenient shape.

Such end caps may be obtained by cutting from a sheet, as mentioned above, or by moulding in accordance with known methods. In the latter case they may comprise at their external faces any kind of surface deformation, hollows or relief elements, which may be required for their mounting in the filter housing.

The material which constitutes them should be of a thermoplastic type with a softening temperature which is relatively indistinct, not a precise softening point. This material should be selected so that this softening point is considerably higher than the ambient temperature in which the cartridge is to operate and considerably lower than the temperature which causes degradation of the filtering element to begin. This material should be resistant to chemical attack, more particularly from petroleum derivatives, and should have low moisture absorption and good mechanical rigidity. Polypropylene meets all these requirements. Its softening point is about 150°C, its chemical resistance is considerable, and it does not take up moisture. Likewise, high-density polyethylene is suitable. Its softening point is about 130°C, its chemical resistance is excellent and it does not absorb much water. Methacrylates also may be used, which have a softening point of about 120°C, and also polyacetal resins whose softening point is about 170°. Any other plastics material which has characteristics of the same type could be used without departing from the framework of the invention.

The filtering element 5 used in this cartridge is usually constituted by a folded porous paper impregnated with synthetic resins. It is also possible to use pleated cotton fabric reinforced with metal gauze or with plastics material or metal perforated envelopes.

Assemblies are thus provided which resist hydrocarbons, are stable to temperature, non-rusting, and without using glue and without any need to use cumbersome moulding tools for the assembly of their component parts.

In the first constructional form of filter cartridge shown in Fig. 1 and Fig. 2, the filtering element 5 is constituted by a folded porous paper rolled on itself in the form of a cylinder. On the two end faces 6 and 7 of

the cylinder there are placed at 1 and 2 the two end caps which are made of polypropylene or a plastics material with similar properties. This assembly is placed between two plates 8 and 9 of an assembly arrangement or jig, which are preferably metal plates and arranged parallel to each other on a mounting which allows them to be moved axially relatively to each other in the directions 10 and 11, producing in these directions an adjustable force which should be less than the crushing strength of the filtering element. When the end caps comprise surface profiling the plates 8 and 9 are then given the necessary recesses for receiving these profilings.

Electrical heating resistances 12 and 13, or tubes through a hot fluid oil or steam flows, extend through the plates 8 and 9, and each plate is thermostatically controlled so as to be able to regulate and maintain its temperature to a predetermined value, which is equal over the two plates.

Under the selected pressure, the heated plates 8 and 9 are applied in the directions 10 and 11 against the end caps 1 and 2 and thus the caps are brought to a temperature near the softening temperature of the material which constitutes them. The operation is very rapid and requires only a few seconds owing to the slight thickness of the end caps. When the temperature is reached, the folded paper 5 penetrates into the thickness of the caps 1 and 2 and the approach of the plates 8 and 9 is stopped when the paper has penetrated within the caps to approximately half the thickness of the said caps. The plates 8 and 9 are then moved away from one another, and the filtering cartridge is put aside to cool down. The plastics material of the end caps hardens very quickly, providing a sealing-tight securing arrangement at the ends of the folded paper 5, which is embedded in the two end caps.

The cartridge assembly thus constructed is very rigid, it can be manipulated without excessive care having to be taken, and mounted within a filter housing adapted to receive the filtering cartridges normally used.

The cartridge thus constructed uses the filtering surface to the maximum, the embedding of the filtering element in the two end caps being over only a very low height. The light weight of the assembly, the low cost price of the materials used, and the rapidity of the assembly operation give a very economical product.

Referring now to Fig. 3, a second constructional form of filtering element is constituted by pleated cotton fabric 14 held between two perforated cylindrical walls 15 and 16 made of metal or plastics material, or constituted by wire gauze. The end caps 17 and 18, which are similar to the caps 1 and 2, in this case have projecting flanges 17-1 and 17-2, 18-1 and 18-2 which make it possible to centre the filtering element 14, 15, 16 when the cartridge is assembled. The plates 19 and 20, corresponding to the plates 8 and 9, in this case only support the end caps 17 and 18 at their inner and outer peripheries, the necessary heat for bringing the end caps to their softening point being supplied by hot air escaping from nozzles 21 and 22.

In respect of the third constructional form of filtering element, shown in Fig. 4, it is first noted that it is possible to obtain, in polypropylene which has been brought to its softening point, the direct embedding of flexible materials such as polyurethane foam, provided that the latter is held in position during operation. Thus Fig. 4 shows a filtering element 23 constituted by polyurethane foam with communicating open cells, or other material of equivalent physical, chemical and thermal properties, which is held internally by a mandrel 24 and externally by a sleeve 25 and, on both ends of this element 23, two end caps 26 and 27 made of polypropylene, similar to the end caps 1 and 2. Here again the plates 28 and 29 are supporting plates, the necessary heat for bringing the end caps to their softening points being supplied in this case by an infra-red radiation emitted by tubes 30 and 31.

The direct heating of the end caps in stoves is not advisable especially when using a filtering element made of folded paper, since passing through stoves tends to soften the paper.

In Fig. 5 there is shown a filter assembly comprising a fourth constructional form of cartridge mounted in position in a filter housing comprising a casing 32 and a cover 33 connected together by any suitable means not shown in the drawing. This is a cartridge similar to Fig. 2 but comprising a sealing means.

On the lower end cap 56, which is obtained by moulding, there is arranged a circular lateral lip 34 at the internal or external periphery of the end cap, this lip being initially obtained by moulding in an inclined position and being deformed to a vertical position when the cartridge is positioned in the casing and the lip 34 bears against a vertical casing wall, for example the central cylindrical outgoing pipe 35 to the engine which is provided on the casing 32. This lip provides sealing-tightness. A similar lip could be provided on the upper end cap 36 but it is preferable to provide sealing-tightness at this place by completely closing this end cap at its centre at 36-1.

Obtaining sealing-tightness by using lateral lips makes it possible to avoid there being a necessity to exert an axial compression force on the filtering element.

Sealing-tightness can also be provided by

beads 37 and 38 of polyurethane or neoprene or a similar material having the same plasticity and high thermal stability. This is the subject of the fifth constructional form of cartridge which is shown in the filter assembly of Fig. 6. These beads may be of the solid compressible type 37 or provided with lips as at 38. They may be attached to projections on the end caps 39 and 40 or positioned between the two heating plates when the cartridge is assembled, to be embedded in the thickness of the end caps at the same time as the filtering element, at the instant when the ends caps reach their softening point, which is still lower than the softening point of the material of which the beads are made.

Fig. 7 shows a filter assembly comprising a sixth constructional form of cartridge, which embodies the invention. The cover 41 of the filter housing is moulded from polypropylene or a similar material and itself constitutes the upper end cap of the filtering cartridge. Annular flanges 42 and 43 serve to centre the filtering element 44 when this element is assembled on the cover, again by means of heat and pressure, generally as described with reference to Fig. 2, Fig. 3 or Fig. 4. The filter casing 45 is fixed by any suitable means on the cover 41, these means not being shown on the drawings. The lower end cap 46 of the cartridge comprises a sealing lip 47 as in the fourth constructional form. This lip, instead of co-operating with a vertical (central cylindrical) portion of the casing 45, can co-operate with the horizontal bottom wall 45-1 of this casing. In this case it projects in a lateral direction from the end cap 46 as shown at 48 and bears against a part of the casing (45-1) perpendicular to the axis thereof. This arrangement, which incorporates the cover in the filtering cartridge, results in a very economical cost price.

Fig. 8 shows a filter assembly comprising a seventh constructional form of cartridge, which also embodies the invention, in which the cover 49 of the filter housing constitutes the upper end cap and the casing 50 constitutes the lower end cap, thus dispensing with both of the separate end caps in the first constructional form. The assembly is assembled in the hot state, again generally as described with reference to Fig. 2, Fig. 3 or Fig. 4.

Ribs 49-1, 49-2 and 50-1, 50-2, formed at the time of moulding the cover and the casing and preferably provided with conical surfaces, serve to centre the filtering element 51 when the cover 49 is closed on the casing 50. When this filtering element enters the cover and the casing to a good depth, which is indicated by obtaining the predetermined external height 52, the two edges 53 and 54 of the cover and casing are caused to bear against one another and are joined at 55 by any known processes, hot air welding, hot squeezing or with ultrasonic means acting on projections, mechanical attachment etc, and this assembly does not require sealing-tightness in this region.

Thus a filter assembly is provided which cannot be disassembled and which is thrown away after it becomes clogged. It should be noted that this filter assembly does not comprise any sealing ring, nor any adhesive, but simply a cover, a casing and a filtering element, the simplest construction of the latter in this case apparently being folded porous paper. This constructional form of the invention is thus particularly economical.

The embodiments of the invention, which have been described with reference to Figs. 7 and 8, may be varied by incorporating or substituting features of the other constructions which have been described with reference to Figs. 1 to 6, apart from the separate end caps.

When, during the assembly of a filter generally as shown in Fig. 7, a bead or lip type sealing portion is provided which is cooperable with a part of the casing, the sealing portion may be heated and embedded in the end cap at the same time as the filter element.

The method aspect of the invention extends to any desired method of heating the end caps.

WHAT WE CLAIM IS:—

1. A filter assembly comprising a filter cartridge including a filter element for filtering any kind of fluid, opposite ends of the filter element being embedded directly in end caps of thermoplastic material, said filter cartridge being housed in a casing with a cover, one of the end caps comprising the cover for the casing.

2. A filter assembly according to claim 1, wherein the other end cap forms the casing which cooperates with the cover.

3. A filter assembly according to claim 1 or 2, wherein said casing and cover are permanently assembled together, the said assembly being intended to be discarded once the filter element has become clogged.

4. A filter assembly according to any one of the preceding claims, wherein cylindrical or frusto-conical annular ribs are provided integrally moulded with the cover and/or the casing for centring the filter element during assembly.

5. A filter assembly according to any one of the preceding claims, wherein the other end cap is provided with a deformable bead or lip type sealing portion of neoprene, polyurethane or a similar material having similar plasticity and high thermal resistance.

6. A filter assembly according to claim 5, wherein the sealing portion includes an annular lip which bears against a part of the

casing perpendicular to the axis thereof or against a central cylindrical portion of the casing.

7. A filter assembly according to any one of the preceding claims for use in an air filter, wherein the filter element is made of porous paper.

8. A filter assembly according to any one of the preceding claims, wherein the end caps are made of polypropylene.

9. A method of assembling a filter cartridge comprising introducing an uncapped end of a filter element into a cover for a casing for the cartridge, the cover being of thermoplastic material, and applying heat to embed and sealingly bond the end of the filter element directly to said cover which then constitutes an end cap for that end of the filter element, and similarly embedding and bonding the opposite end of the filter element to another end cap of thermoplastic material.

10. A method according to claim 9, wherein the heat is applied by means of electrical resistance heaters, tubing carrying a heating fluid, jets of hot air, or infrared heating elements.

11. A method according to claim 9 or 10, wherein the assembly is carried out in an assembly arrangement or jig comprising parallel plates adapted to be displaced axially for exerting a variable force less than the crushing strength of the filter element against the opposed ends of said filter cartridge during the heating of the end caps.

12. A method according to claim 11, wherein the heating means are disposed in the opposed plates and are adapted to heat the corresponding end caps to the same temperature.

13. A method according to any one of claims 9 to 12, wherein during the assembly of the filter cartridge a bead or lip type sealing portion is heated and embedded in the end cap at the same time as the filter element, said bead or lip being so disposed as to cooperate with a part of the casing.

14. A filter assembly substantially as herein described with reference to Fig. 7 or Fig. 8 of the accompanying drawings.

15. A filter cartridge substantially as herein described with reference to Fig. 7 or Fig. 8 of the accompanying drawings.

16. A method of assembling a filter cartridge as claimed in claim 15, the method being substantially as herein described with reference to the drawings.

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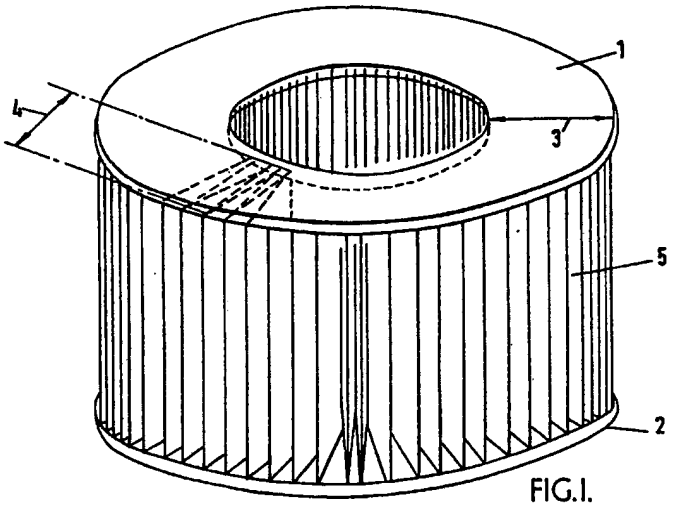

FIG.1.

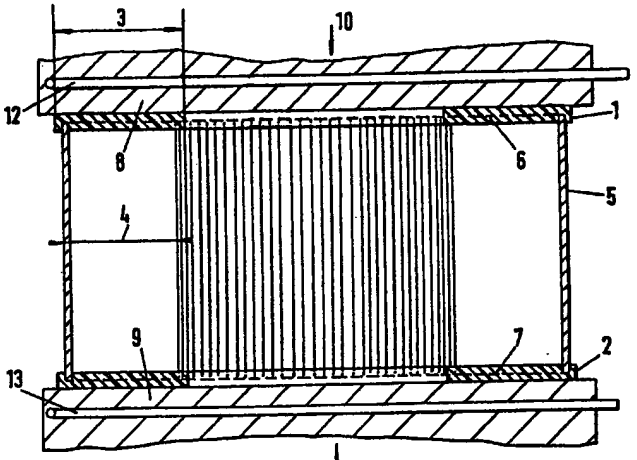

FIG.2.

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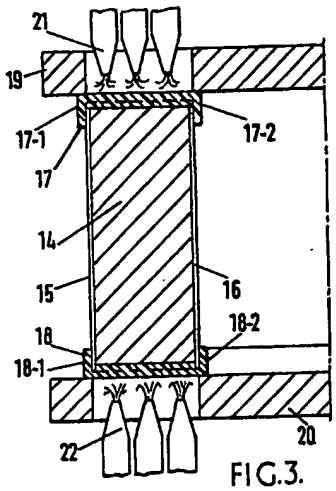

FIG.3.

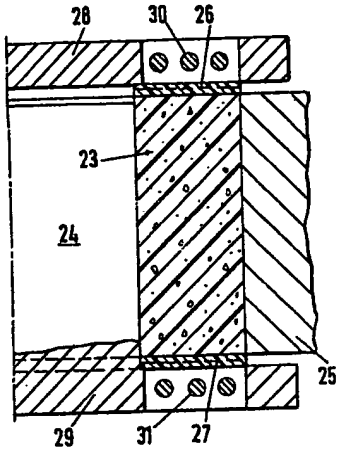

FIG.4.

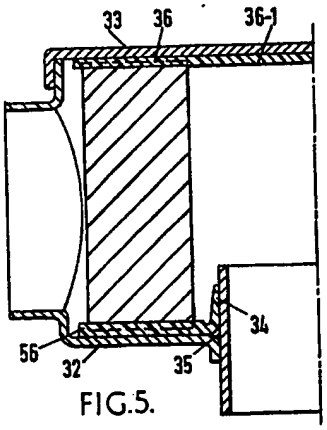

FIG.5.

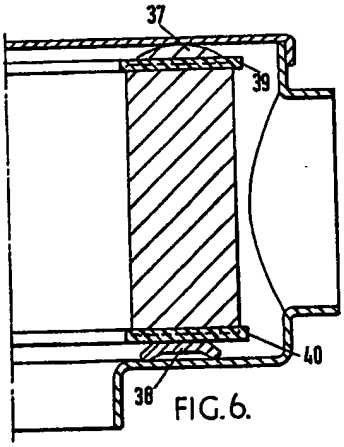

FIG.6.

1511904 COMPLETE SPECIFICATION
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Sheet 3

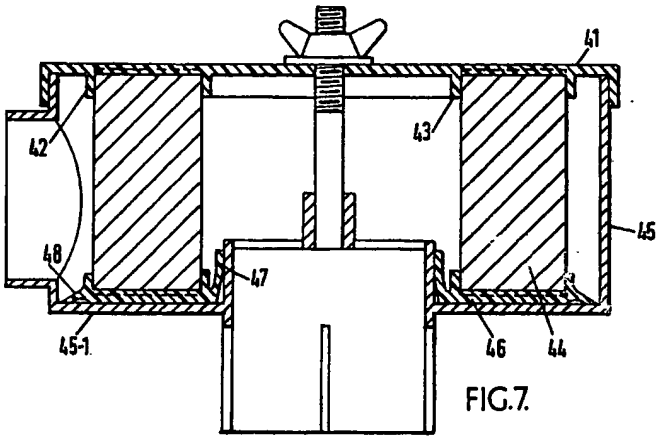

FIG.7.

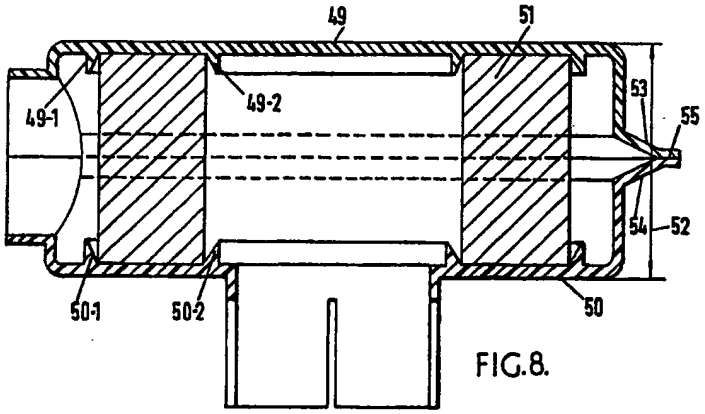

FIG.8.